Optimizing the control of foot-and-mouth disease in Denmark by simulation

Consequences of changes in herd sizes and densities for the contingency planning

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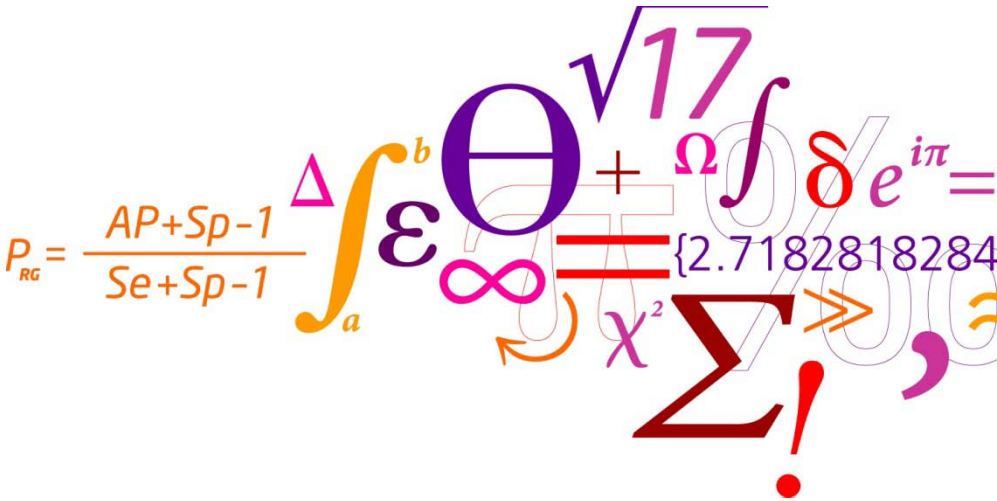

DTU Vet
National Veterinary Institute

Background - 1

- The livestock agricultural sector is expected to change
- Fewer, but larger herds
- Larger distances between herds

Background - 2

- Would FMD spread more or less?
- Would an FMD epidemic cost more or less?
- Would the change in structure of the livestock industry lead to a change in the preferred control strategy?

Methods - data

- Several farm and index files were produced based on our predictions
- All farm files were used to run the basic scenario
- One farm file was chosen
  - Alternative scenarios were run on this farm file
- All inputs were assumed to stay the same as in 2006/2007 simulations
  - Except low risk contacts
    - Increased by 50%
- DTU-DADS and ISP were used to model future scenarios

Methods – control strategies

- Scenarios
  - Basic scenario
    - Basic EU regulations PLUS extra Danish control meassures
  - Pre-emptive depopulation (after 10 det. Herds)
    - In different zone sizes
  - Emergency vaccination (after 10 det. Herds)
    - In different zone sizes

Results – different farm files

- Starting in **high dense cattle** areas – **DTU-DADS**

Farm file Results as median (5-95)	Epidemic duration (days)	Infected herds	Total costs (x€10^6)
AFA	45 (18-98)	58 (14-163)	531 (413-753)
AFB*	41 (16-88)	54 (11-159)	528 (405-746)
BFA	59 (18-150)	83 (13-280)	597 (415-1,011)
BFB	55 (17-146)	74 (13-269)	592 (409-1,021)
CFA	34 (13-68)	38 (11-98)	487 (395-635)
CFB	31 (14-67)	36 (11-100)	482 (398-638)

* log-linear per region for all years and herd categories

Results – different farm files

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* log-linear per region for all years and herd categories. Large herds become larger.

Results – current and future epidemics

- Starting in **high dense cattle** areas – **DTU-DADS** and **ISP**

Results as median (5-95)		Epidemic duration (days)	Infected herds	Total costs (x€10^6)
2006/2007	DTU-DADS	56 (16-142)	67 (13-245)	562 (402-946)
	ISP	80 (5-255)	137 (3-696)	665 (399-1,137)
2030	DTU-DADS	43 (16-344)	55 (11-171)	539 (409-1,412)
	ISP	68 (11-215)	95 (5-371)	658 (416-1,188)

Results – current and future epidemics

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Results – depopulation

- Starting in **high dense cattle** areas – **DTU-DADS** and **ISP**

Depopulation Results as median (5-95)	Epidemic duration (days)	Infected herds	Slaughtered animals (x10^3)	Total costs (x€10^6)
DTU-DADS				
Basic scenario	43 (16-344)	55 (11-171)	26 (4-89)	539 (409-1,412)
Depop 500 m	38 (15-344)	49 (11-155)	30 (5-100)	531 (409-1,317)
Depop 1000 m	35 (15-93)	48 (11-132)	43 (5-134)	523 (409-834)
Depop 1500 m	33 (14-79)	44 (10-125)	63 (7-195)	518 (408-769)
Depop 3000 m	28 (13-59)	39 (10-107)	146 (12-444)	533 (410 -781)
ISP				
Basic scenario	68 (11-215)	95 (5-371)	52 (2-214)	658 (416-1,188)
Depop 500 m	68 (11-216)	99 (5-386)	65 (2-260)	663 (417-1,167)
Depop 1000 m	59 (11-183)	89 (5-348)	93 (2-357)	645 (416-1,128)
Depop 1500 m	59 (10-175)	83 (5-359)	130 (2-557)	659 (414-1,174)
Depop 3000 m	74 (11-205)	84 (5-358)	326 (2-1,145)	747 (422-1399)

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Results – vaccinate to kill (suppressive)

- Starting in **high dense cattle** areas – **DTU-DADS** and **ISP**

VacToKill (VTK) Results as median (5-95)	Epidemic duration (days)	Infected herds	Vaccinated animals (x10^3)	Total costs (x€10^6)
DTU-DADS				
Basic scenario	43 (16-344)	55 (11-171)	-	539 (409-1,412)
VTK 1 km	40 (15-344)	51 (11-162)	24 (0-87)	535 (408-1,413)
VTK 2 km	39 (16-344)	51 (11-148)	84 (2-285)	546 (414-1,459)
VTK 3 km	36 (16-344)	49 (11-144)	157 (6-510)	552 (412-1,488)
VTK 5 km	35 (15-344)	48 (11-127)	345 (16-990)	586 (418-1,502)
ISP				
Basic scenario	68 (11-215)	95 (5-371)	-	657 (415-1,186)
VTK 1 km	60 (11-171)	87 (5-335)	46 (0-185)	626 (414-1057)
VTK 2 km	56 (11-141)	83 (5-285)	151 (0-501)	648 (443-976)
VTK 3 km	51 (11-137)	76 (5-250)	263 (0-855)	533 (390-804)
VTK 5 km	48 (11-119)	69 (5-233)	533 (0-1,572)	650 (456-950)

Results – vaccinate to kill (suppressive)

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Results – vaccinate to live (protective)

- Starting in **high dense cattle** areas – **DTU-DADS** and **ISP**

VacToLive (VTL) Results as median (5-95)	Epidemic duration (days)	Infected herds	Vaccinated animals (x10^3)	Total costs (x€10^6)
DTU-DADS				
Basic scenario	43 (16-344)	55 (11-171)	-	539 (409-1,412)
VTL 1 km	39 (14-344)	51 (10-159)	23 (0-86)	608 (485-1,510)
VTL 2 km	37 (14-344)	48 (10-142)	79 (0-262)	606 (487-1,548)
VTL 3 km	34 (15-344)	45 (11-124)	143 (6-465)	609 (490-1,560)
VTL 5 km	31 (13-344)	43 (10-113)	304 (0-874)	616 (491-1,644)
ISP				
Basic scenario	68 (11-215)	95 (5-371)	-	657 (415-1186)
VTL 1 km	58 (10-168)	84 (5-301)	43 (0-174)	704 (491-1097)
VTL 2 km	48 (10-133)	70 (5-242)	127 (0-450)	662 (482-965)
VTL 3 km	43 (10-120)	66 (5-216)	222 (0-720)	650 (486-938)
VTL 5 km	38 (9-88)	56 (5-188)	417 (0-1,263)	636 (486-836)

Results – vaccinate to live (protective)

- Starting in **high dense cattle** areas – **DTU-DADS** and **ISP**

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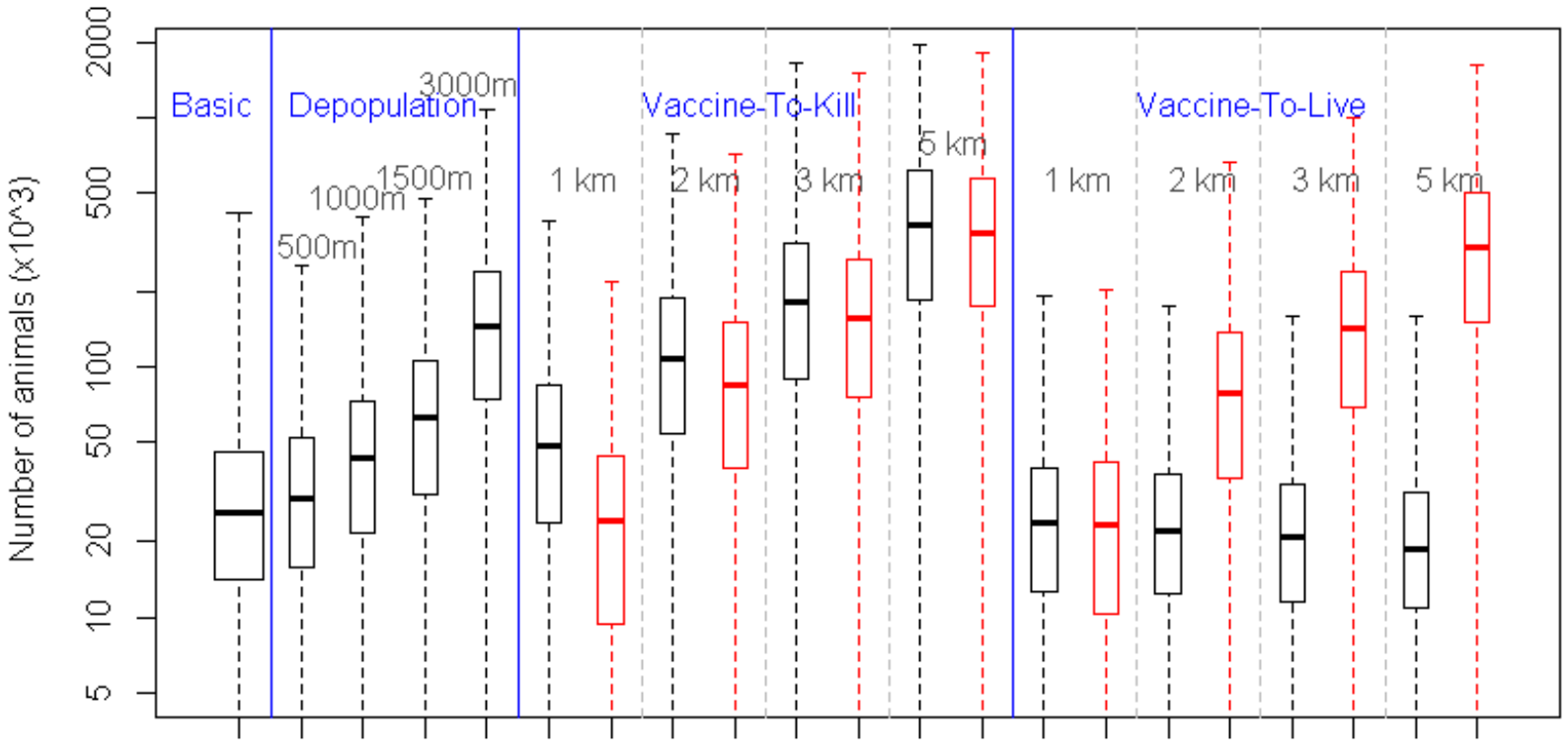
Results – Depopulated animals

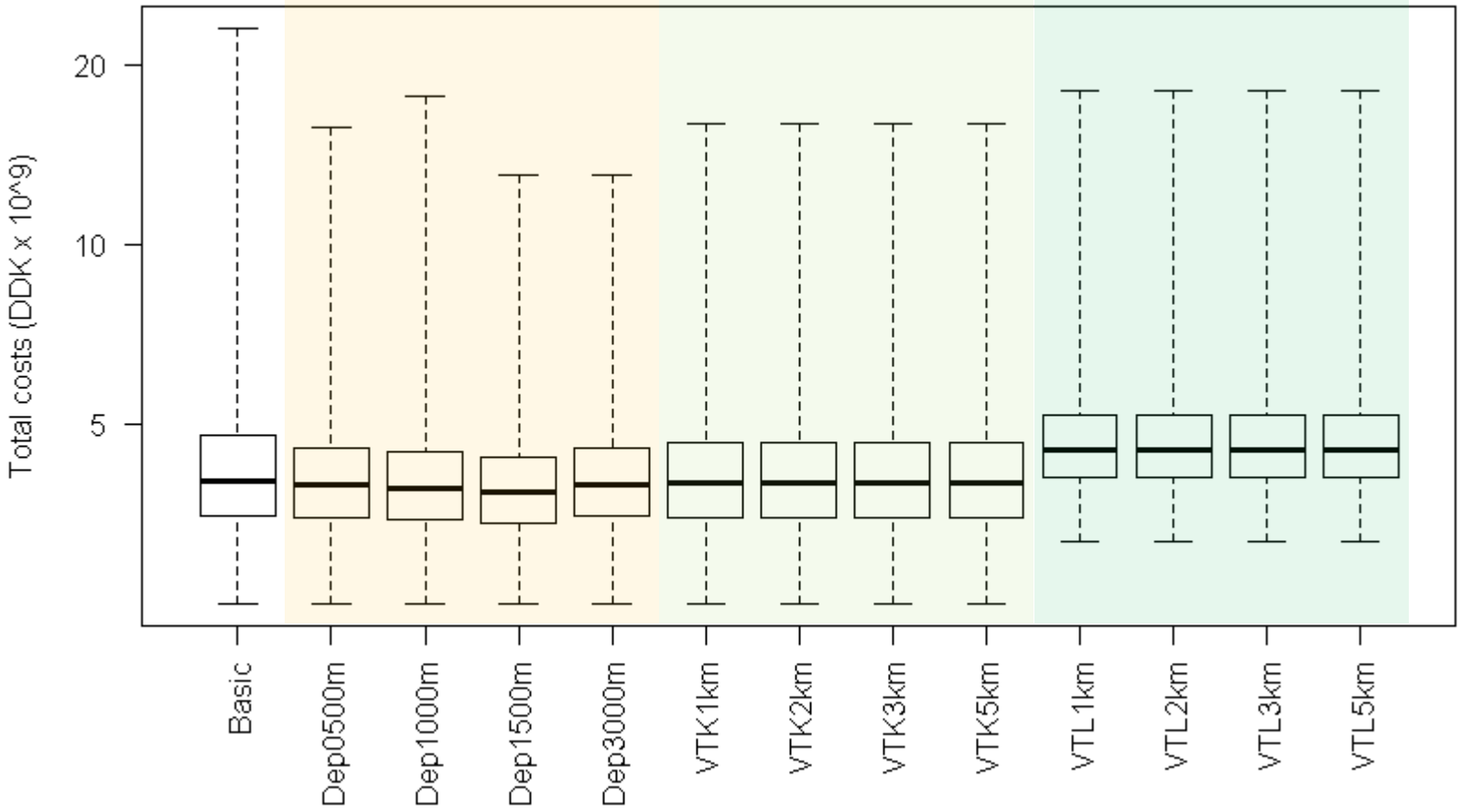
- Starting in **high dense cattle** areas – **DTU-DADS**



Black boxes = depopulated animals Red boxes = vaccinated animals

Results – costs

- Starting in **high dense cattle** areas – **DTU-DADS**



Conclusions - 1

- **Future FMD epidemics are expected to be shorter and involve fewer infected herds**
- **Future epidemics are expected to be less costly**
- **However, extreme epidemics are expected to be larger and more costly**

Conclusions - 2

- **Epidemiologically**
  - **Depopulation OR protective vaccination are both good strategies**
- **Economically**
  - **Depopulation or suppressive vaccination are better**
  - **BUT can result in large number of slaughtered animals**
- **Large zones can lead to extra losses**